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Part I: Overview of Business

- Marshall County Conservation (MCC) manages public land for wildlife, recreation, and conservation education.
- Manage more than 2200 acres on 29 locations.
- Host educational programs for the public and special interest groups.

Part II: Job Specifics

- In 2016, MCC added maple syrup production to their responsibilities as an additional way to engage the public.
- Maple sap collection and conversion to syrup by evaporation are done by the MCC staff.
- Maple syrup is sold to raise money but production is time consuming and labor intensive.

Part III: Introduce the Problem

- The maple syrup evaporator currently being used is too slow and inefficient.
- The evaporator is a simple barrel stove with holes cut in the top for two pans that would be filled with maple sap.
- How can we improve the design of the evaporator to boil-off the water more quickly so we can make more maple syrup?
- How can we make the system more efficient so it uses less fuel?

Part IV: Background

- Students should use their knowledge of evaporation, solutions and concentrations, forms of heat transfer, and insulators.
- Guiding Questions:
  - How can we increase the amount of heat being transferred to the sap?
  - How can we increase the surface area available for conduction?
  - How can we control the convection of heat so it goes where we need?
  - How can we prevent heat from radiating or convecting away from the evaporator?
  - How can we increase the surface area of the maple sap so it can evaporate more quickly?

Part V: Business Solution

- MCC obtained a greatly improved evaporator with many design features that maximized heat transfer to the sap and allowed it to boil more easily.
- Design features include flues for the syrup to travel though that provide greater surface area for heat conduction.
- The sap depth is controlled so more surface area is exposed to increase the rate of evaporation.
- Insulating materials are used to reduce unwanted heat transfer.

Part VI: Student Solutions

- The addition of insulative and reflective materials to reduce unwanted heat transfer.
- Innovative changes in pan design to improve conduction of heat to the sap.
- Creative ways to increase surface area of sap to improve evaporation.
- Changes to the stove to reduce heat lost through chimney and other openings.